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INFLUENCE OF DIETARY FAT ON MENSTRUAL CYCLE AND MENSES LENGTH

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Menstrual cycle and menses lengths were determined in 31 healthy premenopausal women randomized into one of two sets of weight-maintaining diets, those with a ratio of polyunsaturated to saturated fatty acids (P/S ratio) of 1.0 and those with a P/S ratio of 0.3. After a baseline interval of one menstrual cycle, both groups were fed a high fat diet (40 per cent energy from fat) for four menstrual cycles per subject, followed by a similar interval on a low fat diet (20 per cent energy from fat). There was a significant increase of 1.3 d ($P = 0.02$) in the average menstrual cycle length and 0.5 d ($P = 0.01$) in menses length on the low fat diet. Although no significant differences were evident between the P/S groups, the effect of low fat on menstrual cycle and menses length was most pronounced in the P/S = 1.0 group.

Introduction

Diet is known to affect menstrual cycle function. In the extreme, severe energy restriction is associated with amenorrhoea. A more subtle dietary effect was reported by Hill *et al.* (1977, 1984), who found a shortening of menstrual cycle length due to decreased time in the follicular phase among Western Caucasian women who switched to a vegetarian diet. The reverse, a longer follicular phase, was observed among Black South African women given a Western diet. These studies involved free-living women who either recorded their dietary intake or were provided with a prescribed supplemental meal once a day. As part of a long-term feeding study, we evaluated whether the dietary effect report by Hill and his colleagues could be replicated under more controlled circumstances. In the study reported here, menstrual cycle information was collected from 31 healthy premenopausal women consuming weight-maintaining diets of known composition varying in amount and type of fat. This study provided a controlled test of the effect of a high fat versus low fat diet on menses and menstrual cycle length.

Subjects and methods

Premenopausal women aged 20–40 years were recruited to study the effects on various biological parameters of eating high fat (40 per cent energy from fat) compared with low fat (20 per cent energy from fat) diets at low (0.3) or high (1.0) ratios of polyunsaturated to saturated fatty acids (P/S ratios). This study

was approved by the human studies review committees of the National Institutes of Health, US Department of Agriculture, and Georgetown University School of Medicine. Volunteers were screened to eliminate women with health problems, use of oral contraceptives in the past year, regular use of medications, self-reported menstrual irregularities or other reproductive problems, pregnancy or breast-feeding within the last year, and dietary patterns incompatible with the study. Women whose weights were less than 90 per cent or greater than 120 per cent of the 1983 Metropolitan Life Insurance table of 'desirable weights' (Metropolitan Life Insurance Company, 1983) were excluded. Of 37 women who passed the screening evaluations and started the study, 31 completed the study and their data are reported here. The women were randomized to one of two dietary groups (P/S ratios = 0.3 or 1.0) which were maintained throughout both the high and low fat dietary periods. The randomization was accomplished by stratifying according to smoking status and within each group (smokers and nonsmokers) ranking by relative weight (weight/height). A coin was tossed to determine which P/S group the women with odd-numbered ranks would consume and women with even-numbered ranks were assigned to the remaining P/S group.

Dietary intake during the baseline free-living period was determined from analyses of 7-d food records recorded by each woman in the middle of her baseline menstrual cycle. For the controlled dietary periods, diets contributing either 40 per cent or 20 per cent energy from fat with P/S ratios of 0.3 and 1.0 were formulated from commonly available foods. Menus for four caloric intake levels were designed: 1600, 2000, 2400, and 2800 kcal. In order to maintain body weight, whenever a woman gained or lost at least 1 kg and maintained this weight change for at least 3 d, she was moved from one caloric level to another. In reducing the energy intake from fat, the energy from protein was maintained at about 16–17 per cent, while that from carbohydrate was increased. No vitamin or mineral supplements or alcohol were consumed while on the study. Meals were prepared in the Beltsville Human Nutrition Research Center (BHNRC). On weekdays, morning and evening meals were eaten in the BHNRC dining facility and a carry-out lunch was provided. Weekend meals were packaged for home consumption. The mean daily dietary intake for the two P/S groups during the baseline, high fat, and low fat periods is shown in Table 1.

After a free-living baseline period lasting one menstrual cycle, each woman was placed on the high fat diet for four menstrual cycles and then switched to the low fat diet for a similar period of four menstrual cycles. Before breakfast every weekday throughout the study, the women were weighed and turned in calendar slips reporting whether or not they were menstruating. Based upon this information, menstrual cycle and menses length were determined. Menstrual cycle and menses lengths per subject were averaged during the two dietary periods across all cycles except the first on each diet, to allow for a carry-over effect. Two-way repeated measures analysis of variance and paired Student's *t*-tests were used for statistical testing. Non-parametric analyses were also carried out (Wilcoxon rank sum test for P/S comparisons and Wilcoxon signed rank test for paired dietary fat comparisons) as the distribution of menstrual cycle lengths was slightly right-skewed. Results of the non-parametric analyses were identical

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Table 1. *Daily nutrient intakes for subjects in both P/S groups during baseline, high and low fat dietary periods (means with standard error in parenthesis)*

	Baseline (free-living)	*Controlled dietary periods (% energy from fat)*			
		40% P/S ratio		*20% P/S ratio*	
		0.3	*1.0*	*0.3*	*1.0*
No. of subjects	31	15	16	15	16
Energy, kJ	8620 (343)	9530 (272)	9130 (339)	9450 (406)	9240 (460)
Energy, kcal	2060 (82)	2280 (65)	2180 (81)	2260 (97)	2210 (110)
Protein, % energy	14	16	16	17	17
Carbohydrate, % energy	47	45	45	64	64
Fat, % energy	39	39	39	19	19
Saturated fat, g	32.7 (1.7)	44.2 (1.3)	26.8 (1.1)	20.9 (0.7)	12.3 (0.6)
Oleic acid, g	31.5 (1.5)	30.5 (0.9)	33.5 (1.4)	14.9 (0.6)	17.0 (0.8)
Linoleic acid, g	14.1 (1.0)	14.6 (0.4)	26.1 (0.9)	6.9 (0.2)	12.9 (0.6)

to the parametric results. For brevity, only the parametric results are shown. All *P*-values calculated assumed a two-tailed test and an alpha value of 0.05 was considered statistically significant. Statistical analyses were done using the Statistical Analysis System, SAS (SAS Institute Inc., 1985).

Results

The mean menstrual cycle and menses length for each P/S group and the total group during the two dietary regimens are shown in Table 2. No significant differences were evident between the P/S groups within either the high fat or the low fat dietary periods. There was a statistically significant increase of 1.3 d ($P = 0.02$) in the average menstrual cycle length of the subjects when moved from the high to the low fat diet. There was also a statistically significant increase of 0.5 d ($P = 0.01$) in menses length for the total group when moved to the low fat diet. Both changes appeared primarily due to changes in the P/S = 1.0 group, which increased 1.8 d in average menstrual cycle length and 0.8 d in average menses length. There was an apparent slight carry-over effect from the high fat diet during the first cycle on the low fat diet. This is shown in Table 3, where

Table 2. *Menstrual cycle and menses lengths for high and low fat dietary periods by P/S groups (means with standard error in parenthesis)*

	P/S	*High fat*	*Low fat*	*Difference*
Menstrual cycle length, d	1.0 ($n = 16$)	29.2 (1.0)	31.0 (1.6)	1.8 (0.9)
	0.3 ($n = 15$)	28.7 (0.6)	29.5 (0.5)	0.8 (0.5)
	Total ($n = 31$)	28.9 (0.6)	30.3 (0.8)	1.3 (0.5)[a]
Menses length, d	1.0 ($n = 16$)	5.3 (0.3)	6.1 (0.3)	0.8 (0.2)
	0.3 ($n = 15$)	5.4 (0.3)	5.7 (0.3)	0.3 (0.3)
	Total ($n = 31$)	5.4 (0.2)	5.9 (0.2)	0.5 (0.2)[b]

Significance of difference between high and low fat: [a]$P = 0.02$, [b]$P = 0.01$; no significant effect of P/S or interaction between diet and P/S.

Table 3. *Median and mean values for menstrual cycles and menses lengths in 31 subjects during study*

		Menstrual cycle length (d)		*Menses length (d)*	
	Cycle	*Median*	*Mean (s.e.m.)*	*Median*	*Mean (s.e.m.)*
Baseline	1	28	29.7 (0.7)	5	5.4 (0.3)
High fat	2	28	28.4 (0.6)	6	5.6 (0.3)
	3	27	28.5 (0.7)	5	5.2 (0.2)
	4	28	28.9 (0.7)	5	5.4 (0.3)
	5	28.5	28.7 (0.7)	5	5.5 (0.3)
Low fat	6	28	29.3 (0.7)	5	5.3 (0.2)
	7	29	30.5 (1.1)	6	6.2 (0.3)
	8	29	29.1 (0.7)	6	6.1 (0.3)
	9	29	29.6 (0.7)	5.5	5.4 (0.3)

median and mean values for menstrual cycle and menses lengths in the total group during each cycle of the study are presented.

Discussion

The women in this study showed a statistically significant mean individual increase of about 1 d in menstrual cycle and menses length when shifted from a high fat to a low fat diet. Although precise ovulation dates in each menstrual cycle were not known, it is likely that the increase in menstrual cycle length occurred in the follicular phase of the cycle, as the length of the luteal phase is generally much less variable (Matsumoto, Nogami & Ohkuri, 1962). The slight increase in menses length also suggests a follicular phase change.

These findings are contrary to those reported by Hill *et al.* (1977, 1984). Several possible reasons for this difference are apparent. In the studies by Hill and colleagues, women eating a typical Western diet were switched to a vegetarian diet for 2 months. These women were free-living and compliance was determined by weekly 3-d diet records. The estimated change in fat consumption was only 5 per cent of energy (a 13 per cent change in fat), from 38 per cent of energy from fat in the Western diet to 33 per cent in the vegetarian diet. In our study, the women experienced a 50 per cent reduction in fat (decreasing from 40 per cent to 20 per cent of energy from fat) while consuming typical Western foods, including meat. The controlled high fat diet was comparable in percentage energy from fat to the baseline reported dietary intake and is slightly higher than the value reported for the women in Hill's research. Thus, several differences in the dietary treatment are evident and could be influencing the disparate results. It is also possible that the difference is due merely to sample size and the general variability of menstrual cycle lengths. For example, the largest mean individual difference observed in our study was between cycles two and seven. Although this mean increase of 2.2 d was significant for the group, four of the 31 women had no change and eight actually had shorter cycles. It is possible that the samples of four (1977) and sixteen (1984) women observed by Hill *et al.* were simply not large enough to overcome

enses lengths in 31 subjects during study

	Menses length (d)	
ean (s.e.m.)	*Median*	*Mean (s.e.m.)*
9.7 (0.7)	5	5.4 (0.3)
8.4 (0.6)	6	5.6 (0.3)
8.5 (0.7)	5	5.2 (0.2)
8.9 (0.7)	5	5.4 (0.3)
8.7 (0.7)	5	5.5 (0.3)
9.3 (0.7)	5	5.3 (0.2)
0.5 (1.1)	6	6.2 (0.3)
9.1 (0.7)	6	6.1 (0.3)
9.6 (0.7)	5.5	5.4 (0.3)

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the large inter-individual variability in cycle length and to produce the effect observed in this study.

As this group of women met together twice a day on weekdays for approximately 8 months, there was a possibility for menstrual synchrony to influence the data. However, examination of menses starting dates for the women throughout the study showed no evidence of association and previous research on menstrual synchrony (McClintock, 1971; Graham & McGrew, 1980) suggests a much more extensive interaction between women (as in 'close friends') is necessary for synchrony to occur. For menstrual synchrony, if it occurred, to cause the pattern of change observed in this study associated with the dietary change is improbable, although it could have introduced more variability in the cycle lengths, thus decreasing the power to observe any differences in a study with smaller sample size.

The design of our study (four menstrual cycles on a high fat diet followed by four on a low fat diet, with no crossover) and its long duration (approximately 9 months) offer the possibility for a confounding temporal effect. However, we are unaware of data indicating such an effect in human menstrual cycle length. No differences in cycle length were evident in the extreme situation comparing winter and summer in Alaska (Treloar, 1973). Thus, any significant effect between winter and spring in Maryland seems unlikely. Nevertheless, a temporal effect cannot be ruled out as an influence on these findings.

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